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Investigation local switching and self-organization effects on non-polar cuts of lithium niobate

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In this work, we studied experimentally domain formation and interaction on non-polar cuts of congruent lithium niobate (LN) and lithium niobate doped by 5% of MgO (MgO:LN) [1]. Self-organized domain structure on nonpolar cuts of CLN was formed during scanning by biased scanning probe microscope (SPM) tip and by grounded SPM tip in the vicinity of the previously formed by pulse application single wedge-like domain. In the last case, charge injected by application of the bias to SPM tip during initial polarization reversal was responsible to further screening of the surface charge to the grounded SPM tip and subsequent realization of local switching by this induced electric field. In both cases, formation of self-organized domain structure was found and attributed to electrostatic interaction of the charged domain apexes of growing domains (charged domain walls). The domain lengths alternating in arrays produced by local switching on nonpolar cut of MgOLN were found to be strongly dependent on the period (spacing between neighboring domains) [1]. Effect of period multiplication of domain array (doubling and quadrupling) and chaotic behavior have been observed (Fig. 1) similar to quasi-periodic domain structures reported earlier to be switched on polar cut of LN [2].

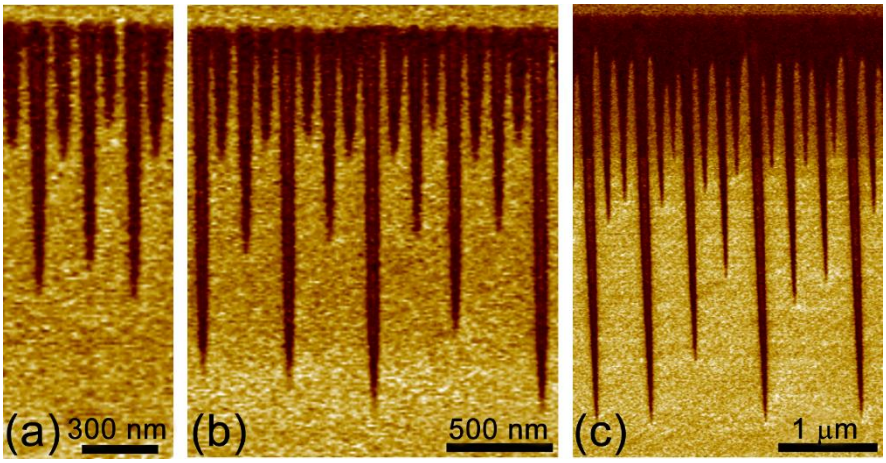

Figure 1. PFM images demonstrating different regimes of polarization switching on X-cut lithium niobate surfaces: (a) doubling, U = 100V, (b) quadrupling, U = 100 V, (c) chaotic behaviour, U = 150 V.

Revealed self-assembled domain growth and interaction of the charged domain walls can provide useful basis for application in nanodomain engineering and development of non-linear optical frequency converters, data storage, and computational devices.

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1. A.P. Turygin, D.O. Alikin, Y.M. Alikin, V.Ya. Shur, *Materials*, **10**, 1143 (2017).
2. A.V. Ievlev, S. Jesse, A.N. Morozovska, E. Strelcov, E.A. Eliseev, Y.V. Pershin, A. Kumar, V.Ya. Shur, S.V. Kalinin, *Nature Phys.* **10**, 59 (2014).